

Remarks

Reconsideration and allowance of the application in view of the following remarks is respectfully requested.

Prior to discussing the prior art rejections, Applicants take this opportunity to set forth the following brief remarks about their invention. Applicants have provided an improved welding method, in which improved welds are produced utilizing a laser generated self healing keyhole. Specifically, a focused laser beam provides a continuous molten pool between the metal components being welded, wherein the keyhole is provided within the molten pool. By simultaneously translating the focused beam along the joining region (first direction) and oscillating the beam relative to the molten pool at a direction different from the first direction, the keyhole is continuously moved and immediately refilled by the adjoining molten metal. None of the applied prior art references teaches or suggests providing a keyhole with a high power density laser beam and oscillating the laser in a manner to fill the keyhole with molten metal, while generating the weld. Thus, Applicants respectfully submit that the application is in condition for immediate allowance.

Turning to the Office Action, the Examiner rejected Claims 1-6, 8, 10-14, and 16-17, as allegedly obvious, under 35 U.S.C. §103, over the U.S. Patent No. 5,595,670 to Mombo-Caristan ("Mombo-Caristan '670"), in view of JP 60-148670 ("JP '670"). Claim 7 stands rejected under 35 U.S.C. §103(a) as allegedly being unpatentable Mombo-Caristan, in view of to JP '670 and U.S. Patent No. 6,410,882 to Okada ("Okada").

Claim 9 stands rejected under 35 U.S.C. §103(a) as allegedly being unpatentable Mombo-Caristan, in view of to JP '670 and U.S. Patent No. 5,603,853 to Mombo-Cartisan ("Mombo-Cartisan '853"). Applicants respectfully traverse the rejections for the following reasons.

To establish a prima facie case of obviousness three criteria must be met. First there must be some suggestion or motivation, either in the references themselves or the knowledge generally available to one of ordinary skill in the art, to modify the reference or to combine reference teachings. *In re Rouffet*, 149 F.3d 1350, 1357, 47 USPQ2d 1543, 1457-58 (Fed. Cir. 1998). Second, there must be a reasonable expectation of success. *In re Merck & Co, Inc.*, 800 F.2d 1091, 231 USPQ 375 (Fed. Cir. 1986). Finally, the prior art reference (or references) combined must teach or suggest all of the claimed limitations. *In re Royka*, 490 F.2d 981, 180 USPQ 580 (CCPA 1974).

Applicants submit that the applied references fail to render Applicants' claimed invention unpatentable, since none of the applied prior art, either alone or in combination teach or suggest a laser welding method that forms a keyhole in a molten pool of metal and then oscillates the keyhole through the pool of molten metal so that the molten metal fills into the keyhole as it is traversed during the welding process, as recited in Claim 1. "To establish a prima facie case of obviousness of a claimed invention all the claimed limitations must be taught or suggested by the prior art". *In re Wilson*, 424 F.2d 1382, 1385, 165 USPQ 44, 496 (CCPA 1970).

Turning first to the rejection of Claims 1-6, 8, 10-14, and 16-17, under 35 U.S.C. §103, over the combination of Mombo-Caristan '670 and JP '670', applicants submit that the applied prior art references either alone or in combination fails to teach each and every limitation of Applicants' method.

Mombo-Caristan '670 fails to teach or suggest a welding method that uses a highly focused laser with maximized power density to provide a keyhole within a molten pool of metal, wherein the oscillation of the laser provides that the molten metal fills the keyhole as it transverses along the weld.

Referring to the end of Page 2 and the first paragraph of Page 3 of the present Office Action, it is the Examiner's position that Mombo-Caristan '670 discloses a method of laser welding a pair of metal sheets using a beam that is focused into an oblong spot, in which the power is such that a keyhole is formed. Applicants respectfully disagree and submit the following.

Mombo-Caristan '670 discloses laser beam welding using an oblong beam spot that may be oscillated back and forth about an axis of the beam spot, as shown in Figure 11. Such an arrangement does not produce a stable keyhole in the welding region, because the laser beam power density at the oblong beam spot is greatly reduced. With the laser power output taught by the Mombo-Caristan '670 patent (1-3 kw), it is impossible to establish a stable keyhole as required by the present invention. The establishment of a self healing keyhole is determined by the laser beam power density at the focal point of the beam. A stable keyhole is provided by a laser having a power

density of at least 10 kw/square centimeter. The use of an oblong shape beam spot drastically reduces the power density of the beam, which in turn requires extremely high laser power outputs. The Mombo-Caristan '670 patent does not appreciate these drawback to laser beam welding using an oblong beam spot.

Referring to Col. 14, lines 32-40 of the Mombo-Caristan '670 reference, Mombo-Caristan '670 disclose that oscillation of the oblong beam spot is performed in order to either bridge the gap of wider joints between welded structures or to initiate melting solidification and remelting resolidification to release gases from the weld region. *See* Col. 14, lines 32 to 40. The oscillation taught by the Mombo-Caristan '670 patent increases weld solidification rate by using lower power outputs in conjunction with oscillation which in turn provides less time for discontinuities in the weld to evolve and be released during solidification.

By contrast, the circular laser beam spot used in the present invention and appropriate power densities forms and sustains a stable keyhole that moves and oscillates through a pool of molten metal to create a self healing keyhole mechanism that slows down the weld solidification rate and improves weld quality. The Mombo-Caristan '670 patent teaches that an oblong beam spot is oscillated across the component interface. It does not appreciate the benefit of oscillating a keyhole through molten metal with higher power output, which increases power density that develops and sustains the keyhole mode and increases that heat input per linear length of weld and thus reduces the solidification rate of the molten pool. In fact, the Mombo-Caristan '670 patent teaches away from such

a practice since the welding heat input into the molten pool with lower laser power output and use of an oblong beam is reduced, thus increasing the solidification rate of the molten pool.

Therefore, since Mombo-Caristan '670 fails to teach or suggest providing a keyhole with a laser, in which the keyhole is filled with molten metal as the keyhole is traversed along the weld, Mombo-Caristan '670 fails to teach or suggest each and every limitation of applicants claimed method, as recited in Claim 1.

JP '670 fails to fulfill the deficiencies in the Mombo-Caristan '670 reference, since the applied secondary reference fails to utilize a laser beam to generate a keyhole that oscillates through a pool of molten metal, wherein the molten metal fills into the keyhole as the position of the keyhole changes, as recited in amended Claim 1. JP' 670 discloses a high speed plasma arc welding method, in which the keyhole that is provided by the plasma torch is stabilized by a laser directed to the front surface of the keyhole.

Applicants note that the keyhole is provided by the plasma torch and not the laser beam. Therefore, since JP '670 fails to teach or suggest providing a keyhole with a laser, in which the keyhole is filled with molten metal as the keyhole is traversed along the weld, JP '670 fails to teach or suggest each and every limitation of Applicants' claimed method, as recited in Claim 1.

Turning to the § 103 rejection of Claim 7 over the combination of Mombo-Caristan '670, JP '670 and Okada, Applicants submit that the combined prior art fails to render Applicants invention unpatentable. Mombo-Caristan '670 and JP' 670 fail to render

Claim 7 obvious for the same reasons the applied references fail to render Claim 1 obvious. If an independent claim is non-obvious under 35 U.S.C. §103(a), then any claim depending therefrom is non-obvious. *In re Fine*, 837F.2d 1071, 5 USPQ2d 1596 (Fed. Cir. 1988). To reiterate, Mombo-Caristan '670 and JP '670 fail to teach or suggest providing a keyhole with a laser, in which the keyhole is filled with molten metal as the keyhole is traversed along the weld.

Okada does not account for the deficiencies in Mombo-Caristan '670 and JP '670, since Okada also fails to teach or suggest laser welding in which the laser provides a keyhole that is filled with molten metal as the keyhole is traversed along the weld, as recited in claim 1.

Okada teaches movement of an optical system (mirror, lenses, etc.) in a laser apparatus with the aid of a piezoelectric-actuator, in a manner that vibrates the focused laser beam, in the optical axis direction. Okada's technique of "mixing" molten metal, is guaranteed to repeatedly obliterate (or destroy) the keyhole, since the focused beam of the Okada system vibrates at ultrasonic frequencies that far exceed the frequencies and speeds at which the keyhole can form and be moved (or translated) without being destroyed. The near ultrasonic frequency of Okada's focused beam increases the chance for the formation of voids, due to the uncontrolled "obliteration" (destruction) of the keyhole, which in turn leads to uncontrolled behavior of the solidifying weld, especially at the deeper (i.e. away from the beam side) portions of the welds. Contrary to the disclosure of Okada, Applicant's self-healing keyhole, by remaining confined within the

molten pool, substantially reduces the formation of voids by the pre-mature collapse of the keyhole.

Therefore, since Okada fails to teach or suggest providing a keyhole with a laser, in which the keyhole is filled with molten metal as the keyhole is traversed along the weld, Okada fails to teach or suggest each and every limitation of Applicants' claimed method.

Turning to the Rejection of Claim 9, under §103(a) over the combination of Mombo-Caristan '670, JP '670 and Mombo-Caristan '853, Applicants submit that Mombo-Caristan '853 fails to render Applicants' claimed method unpatentable, since Mombo-Caristan '853 also fails to teach or suggest laser welding in which a high power density laser provides a keyhole that is filled with molten metal as the keyhole is traversed along the weld, as recited in Claim 1.

Mombo-Caristan '853 discloses a concept for lap-welding the edges of overlapping parts (sheet). Mombo-Caristan '853 disclose that gaps larger than 0.1 mm may be filled in laser welding using a fill-in material. Mombo-Caristan '853 fail to provide a laser having a high power density that would provide a keyhole. In each of the embodiments of the Mombo-Caristan '853 disclosure, lower power density shaped laser beams, such as oblong and rectangular welding beam spots, as depicted in Figure 4, 5C, 5D, 6A and 6B are utilized to provide lap welds.

Therefore, since Mombo-Caristan '853 fail to teach or suggest providing a keyhole with a laser, Mombo-Caristan '853 fails to teach or suggest each and every limitation of applicants claimed method.

In light of the above, Applicants submit that the present §103 rejection has been obviated, since the combination of Mombo-Caristan '670, Mombo-Caristan '853, JP '670, and Okada fail to teach or suggest laser welding in which a laser provides a keyhole that is filled with molten metal as the keyhole is traversed along the weld, as recited in Claim 1.

The §103 rejections also fail because there is no motivation in the applied references that suggests modifying the processes disclosed therein to include Applicants' claimed method, which produces a keyhole using a high power density laser. The rejections are thus improper since the prior art does not suggest this drastic modification. The law requires that a prior art reference provide some teaching, suggestion, or motivation to make the modification obvious.

Here, there is no motivation provided in the disclosures of the applied prior art references, or otherwise of record, which would lead one skilled in the art to modify the structures of the applied references to include a high power density laser that would provide a stabilized keyhole that is filled with molten metal as the keyhole is traversed during the weld operation. "The mere fact that the prior art may be modified in the manner suggested by the Examiner does not make the modification obvious unless the

prior art suggested the desirability of the modification.” *In re Fritch*, 972 F.2d, 1260,1266, 23 USPQ 1780,1783-84 (Fed. Cir. 1992).

Applicants’ submit that the primary reference, Mombo-Caristan ‘670, teaches away from using a high power density laser in a manner that would provide the claimed keyhole, since Mombo-Caristan ‘670 teaches that it is advantageous to reduce the power density of the oblong beam spot to maximize welding speed, while minimizing welding defects. *See* Abstract of Mombo-Caristan ‘670. A prior art reference must be considered in its entirety, i.e., as a whole, including portions that would lead away from the claimed invention. *W.L. Gore and Associates, Inc. v. Garlock, Inc.*, 721 F.2d 1540, 220 USPQ 303 (Fed. Cir. 1983). It is improper to modify references where the references teach away from their modification. *In re Graselli*, 713 F.2d 731, 743, 218 USPQ 769, 779 (Fed. Cir. 1983). Therefore, one skilled in the art would not modify the disclosure of Mombo-Caristan ‘670 to meet the limitation of operating a laser at a power density that would form a keyhole, as required by Claim 1.

There is no suggestion in the prior art of Applicants’ method, therefore all the claims of the present application are not obvious from the combined prior art references cited in the present Office Action.

Based on the above amendments and remarks, the §103 rejections citing Mombo-Caristan ‘670, JP ‘670, Mombo-Caristan ‘853, or Okada have been obviated; therefore reconsideration and withdrawal of the instant rejections are respectfully requested.

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Thus, in view of the foregoing amendments and remarks, it is firmly believed that the present case is in condition for allowance, which action is earnestly solicited.

Respectfully submitted,



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